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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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THE MODERN INCANDESCENT ELECTRIC LAMP.

The Incandescent Lamp and its Manufacture. By Gilbert S. Ram. (London: *The Electrician* Printing and Publishing Company, Limited.)

NOW the Swan-Edison monopoly is a thing of the past, the manufacture of incandescent lamps is assuming considerable proportions; consumers are already deluged with applications for orders by continental firms, and it is to be hoped that we shall not long be obliged to send abroad for what can so easily be made in our own country. The information in this book is of a unique and valuable nature, and the author seems to have a thoroughly practical acquaintance with the subject, and goes into minute details when dealing with all the different branches of the manufacture. Indeed "trade secretism" seems to have been abolished in these pages, and the wealth of technical information here met with will go far towards the production of a more efficient lamp than those at present in use.

Chapter i. treats of the filament, and after briefly touching on the early efforts to produce lamps with incandescent platinum, and the possibilities of making use of some of the metallic oxides, the author passes to the consideration of carbon filaments now used. It is here noted that "great improvements may yet be looked for in the carbon itself." This is a matter of supreme importance, for the incandescent lamp is as yet in such an early stage of evolution as to make it more than probable that the widening of the sphere of manufacture will soon bring about an advance upon its present excellence; and although, as the author points out, the volatilisation of carbon in vacuo will prevent us from attaining to the brightness of the crater of an arc lamp, still there is considerable room for improvement. The "electrical volatilisation" or dissociation of particles of carbon from the filament is noted, and the conclusion is drawn that "the best carbon is one which at the highest possible temperature disintegrates at the slowest rate."

The value of a lamp from the consumer's point of view

must now be modified, since, by the lowering of the price to 1s., the filament can be run at a much higher temperature; for although the life will be thus reduced, this will be more than compensated by the smaller quantity of current used.

The materials at present used for the production of carbon filaments—silk, hair, wood fibre, cellulose—are described, and then chapter ii. begins with the practical preparation of filaments. Swan's process for the parchmentising of cotton thread is taken first, and a good working sketch is given of an apparatus for producing the thread, together with full instructions for the manipulation and drying. Details are also given of the jewelled draw-plates used for bringing down the dried thread to a uniform diameter. This process is the one to which the author devotes most attention. Other processes, such as those in which zinc chloride, furfural, cuprammonia, pyroxyline and bamboo are used, are mentioned with more brevity.

Carbonisation is very fully treated of, and excellent drawings are given of frames and blocks for holding the filaments during heating. The furnace is then considered, and a drawing is given of a convenient form of carbonising furnace, the chapter closing with instructions for removing the fragile carbons from their frames.

Chapter iv treats of mounting the filaments on their leading-in wires, and after describing the early form of crayon holder used by Swan, the carbon tube of Lane Fox, and the bolt and nut of Maxim, he passes on to the perfection of all joints—that of deposited carbon. Drawings are shown of machines for making this joint, both in the "socket" and "butt" form, and minute instructions are given for depositing the carbon on the junctions, particularly from a liquid hydrocarbon. That recommended is a mixture of four parts kerosine to one part turpentine.

The next chapter goes thoroughly into the subject of "flashing." Touching briefly on the early days when carbon was deposited on the filament to remedy defects in their uniformity and remove bright spots, the author gives as the reason why it is still necessary to use the process "that the carbon deposited by the flashing process under certain conditions is much more durable than any that can be produced by any other methods." The

various means that have been proposed and used for producing the deposit are then shown, and drawings are given for an apparatus for "coal gas flashing" at atmospheric pressure. It is, however, recommended that the pressure should be reduced, as otherwise there is danger of getting a soft deposit. A detailed description is next given with drawings of an apparatus for flashing in "pentane" vapour at reduced pressure. Different methods for flashing filaments to a uniform resistance or candle-power are described, and it is noted that the specific resistance of hard white carbon deposited from pentane is one-tenth that of carbon deposited from amyloid. Several pages are given to a consideration of the best thickness for the deposited carbon, and a curve diagram is given, showing the effect of reduction of resistance due to flashing for filaments of various diameters.

In chapter vi. are given useful formulæ for finding the sizes for filaments for lamps of various candle-powers, with either round, flat, square, or tubular filaments, based on the data obtained from amyloid carbon with unpolished surface. In connection with tubular filaments, the fallacy of supposing them to be more economical than the solid form "because all the power is used in heating the surface," is explained.

Chapter vii. gives the sizes necessary for the production of lamps of various candle-powers, using flashed filaments. This is far more difficult than in the case of unflashed carbons, and instead of giving the cumbersome formula necessary, a number of different cases are worked out separately, and the results given in a series of curves from which the sizes for any other candle-power can be quickly obtained. At the conclusion of this chapter, the author alludes to a very amusing instance of what he calls the "happy-go-lucky" method of working that he encountered in a factory some few years ago. The name of the works in question is not divulged, and as he speaks of it being in a country where "very badly matched lamps" could be sold as of the same voltage, we hope England is not responsible. We thoroughly endorse his opinion that the most carefully made lamps, even though the price may be higher, will prove the cheapest in the end. This is a point in the manufacture of lamps which deserves more attention than is usually given to it, and a thorough grasp of the contents of these chapters will be of great value to anyone intending to take up the subject seriously. The aim of the manufacturer should be to turn out the most perfect lamp possible, and one in which the limit of endurance has been attained. Practice will then reduce the cost of production.

Chapter viii. contains a brief description of various gauges used for measuring the diameters of filaments. Although it is not mentioned, we should think the beautiful little instrument used for measuring the thickness of microscopic cover glasses would answer the purpose admirably.

A chapter is devoted to glass-making, including a list of ingredients necessary for the manufacture of lead glass, the kind of pots for melting the "metal" in, and a short description of the method of blowing "pot-bulbs" in a mould. Glass-blowing is fully gone into, and, after describing the playful way in which the old-fashioned orthodox glass-blowers "spoiled" the electricians in the early days of lamp-making, we come to the invention of

the glass-blowing machine, and the final springing into existence of a race of girl glass-blowers free from the vices of drink, strikes, and "Saint Monday."

We then have a few pages with illustrations showing the various forms of blowpipes, ending with practical instructions for making lamp bulbs from glass cylinders. This is given somewhat briefly, doubtless owing to the fact that it is pretty evident that the day is not far distant when this method of forming bulbs will entirely give place to the quicker and more suitable method of "pot-blowing."

Chapter xi. is headed "Sealing in," and contains some good drawings and descriptions of the methods used for fixing the filaments in the glass bulb. The small annealing oven to stand on the workman's bench, and receive the lamps as they are finished, is a very useful piece of apparatus, and is a great advance upon the old method of holding the work in a smoky flame, a practice which is not only dirty, but wastes both time and gas.

Touching upon glass grinding and the manufacture of taps, it is remarked that good taps can be bought cheaply made of German glass, but there is very great difficulty in joining them to the lead glass used in the exhausting apparatus. It is not generally known that this can be easily and effectually done by interposing between the German and the lead glass a thin stratum of soft white enamel or "arsenic" glass, used as a solder. Compound joints made in this way are perfectly sound, and are not at all liable to crack.

The important subject of exhausting is treated of in chapter xii. and it is pointed out that to produce a good lamp a high vacuum is absolutely necessary. The reasons against leaving a residual atmosphere of nitrogen or other inert gas are discussed, and then follows a complete description of the various forms of mercurial pumps in use. Several kinds of short-legged pumps are shown and described in detail. The "Sprengel pump" does not hold the prominent place it occupied some years ago, preference being given to the various forms of Geissler pump. The reason for this may lie in the great number of india-rubber joints that appear to be used. This way of making pumps always gives constant trouble through leakage, and poor efficiency is unavoidable. We cannot agree with the author that india-rubber joints are to be allowed. There is no doubt that india-rubber joints are almost universal in modern lamp factories, but we have equally little doubt that the short life of many of the lamps now on the market is due to imperfect exhaustion; and having had considerable experience in high vacua, we have no hesitation in saying that a vacuum sufficiently good for a long-lived incandescent lamp can only be obtained if all the joints are hermetically sealed together. We have still in use lamps dating from 1882 exhausted properly with sealed joints, and they have outlived generations of bought lamps made with the use of india-rubber joints.

For testing the vacuum the McLeod gauge is noted, but is not considered to be of much use to the lamp-maker. The size of the bubble in the chamber of the "Geissler," and the appearance and "hammer" of the mercury in the legs of the "Sprengel," are taken as sufficiently good indications for the purpose. This certainly savours of the "rough and ready" method, but in the absence of

any good indicator it probably answers the purpose. The coil test is mentioned, but it is very properly pointed out that the appearance of the luminosity in an exhausted bulb is not "under all conditions an indication of the state of the vacuum."

A good chapter is devoted to the testing of voltage and candle-power. The methods of using the photometer are fully described; the "Harcourt" pentane lamp is said to make the most trustworthy standard, but for regular factory use an argand burner with a Methven screen is recommended. This is occasionally tested with the pentane lamp. Then follows a full description, with drawings, of Evershed's wattmeter; and the chapter closes with a method of finding the mean horizontal candle-power of lamps with either flat or cylindrical filaments.

A short description is given of the method of capping the finished lamp. The author finds that the addition of a small percentage of dextrine to the plaster of paris makes a very hard cement, and he warns makers against using an acid flux for soldering the wires and connections. Nothing but rosin should ever be used.

In the chapter on efficiency and duration, allusion is made to the expression "watts per candle-power," instead of the more correct term "candle-power per watt," pointing out that it is more easy to grasp the meaning of a certain number of watts than of a particular fraction of a candle-power. In connection with duration tests, it is very justly said that "life tests pure and simple" are worthless unless the actual candle-power of the lamp at different periods of its life are given.

In the life of a lamp the advantage of the hard coating of deposited carbon shows itself. This hard carbon, combined with a good vacuum, greatly retards the falling off of candle-power due to the blackening of the bulb. It is explained that the disintegration of the carbon acts in three ways. Firstly, by coating the glass with deposited carbon and thus obscuring the light; secondly, by altering the surface of the filament and increasing its emissivity so that it is at a lower temperature; and thirdly, by increasing its resistance so that it takes less current. The data of experimental tests on several lamps for efficiency and duration close the chapter.

The last chapter takes up the relation between light and power in incandescent lamps, and details are given of the recent tests made under the direction of Prof. Ayrton at the City and Guilds of London Institute, with drawings of curve diagrams showing the candle-power and watts of lamps of various makes, up to the breaking point. In conclusion it is said that the ideal lamp would be one in which the radiation is wholly luminous, and that the carbon incandescent lamp falls very short of this desirable consummation. Brief reference is made to the beautiful experiment of Nicola Tesla.

On the whole, readers will find the book to be of very considerable interest, dealing as it does with an entirely new industry of very great elegance; and the practical knowledge diffused by its publication will certainly help to advance the evolution of an efficient lamp which can be sold for a reasonable price.

ALGEDONICS.

Pain, Pleasure, and Æsthetics; an Essay concerning the Psychology of Pain and Pleasure, with special reference to Æsthetics. By Henry Rutgers Marshall, M.A. (London: Macmillan, 1894.)

ALGEDONICS is the term which Mr. Marshall suggests for the science of pain and pleasure. In his sixth chapter he gives the derivation of the term thus: "*ἄλγος*, [pleasure; *ἥδονή*, pain"; the discovery of which, when he glanced over the pages of the completed volume, must, we fear, have given him an algedonic thrill. There is good stuff in the work, and the author is evidently well up in the literature of his subject.

In the first chapter, on the classification of pleasure and pain, Mr. Marshall discusses the psychological status of algedonic states. He argues, successfully we think, against the view that pleasure and pain are psychical elements *sui generis* with special nerves and specialised cerebral centres; and for the view that they are due to algedonic tone associated with any or all of the psychical elements. "Pleasures and pains," he says, "may be differential qualities of all mental states of such nature that one of them must, and either of them may, under proper conditions, belong to any element of consciousness." In his discussion, however, he does not bring out the fact, which is readily explicable on his view, that in popular speech we apply the term pain to the somewhat heightened affections of common sensibility, even when these affections are pleasurable. If, for example, we lightly touch a slight bruise, we term the sensation pain; but such "pain" may be, if we can trust our own experience, distinctly pleasurable. Since the fibres by which impulses from the nerve endings of common sensibility are transmitted, have special cortical endings, and seem to run, in part at least, along different tracts or in a different manner in the spinal cord, some colour has been lent to the view, that there are specialised fibres and centres for pain. If, however, such "pain" is merely the algedonic tone of common sensibility (as hinted, but not in so many words, by Mr. Marshall, on p. 18), these observations are quite in accordance with the view which our author advocates. Mr. Marshall quotes Mr. Herbert Spencer's opinion that "a relation proves itself to be itself a kind of feeling—the momentary feeling accompanying the transition from one conspicuous feeling to another." The word "feeling" is here used in its most general sense as an affection of consciousness. But Mr. Marshall appears to miss the importance of the fact that such feelings of relation have their algedonic tone no less than sense-impressions, a realisation of which would, we think, have helped him in his consideration of æsthetics.

In accordance with the view adopted in chapter i., we find that the emotions are regarded in the second chapter as deriving their character from the algedonic tone of complex co-ordinations of motor activity. Describing the psychological equivalents of these complex co-ordinations as, in their sensation aspect, "instinct-feelings," he regards them in their algedonic aspect as emotions. But here again he is rightly anxious to lay stress upon the fact, that the emotions, like pleasure and pain, are not some-